

eCAADe Vienna 97 Challenges of the Future

Authors: Jen Kokosalakis, Gary Brown, Jon Moorhouse, Liverpool, UK

Institution: Liverpool John Moores University, School of the Built Environment  
Centre for Architecture, John Foster Building, 98 Mount Pleasant  
Liverpool, L3 5UZ, ENGLAND

Tel: +44 151 231 3708

Fax: +44 151 707 2953

email: j.kokosalakis@livjm.ac.uk g.brown@livjm.ac.uk j.moorhouse@livjm.ac.uk

### **Incremental reflective learning and innovative practice in Electronic Design Media**

Keywords: incremental learning, understanding, CAADesign approaches (process), CAADesigns (product), retention, feedback, review, urban spatial forms, spatial analysis, "interstitial layers", patterns, conceptual electronic designing, creative innovation, equality and sharing

#### **Abstract**

*This paper discusses the impact of a continuously developing CAAD learning strategy, describing in detail a few of these principles, and considering their dynamic impact through deeper more lasting learning, feeding a substantial intensification in the application of Architectural Designing with Computers, changing design methods with interesting analytical and creative results. Aspects of the CAAD teaching discussed include extended collaboration between CAAD and design tutors in defining learning outcomes and tutoring the students' application of CAAD to design projects, inclusion of CAAD within traditional interim reviews and feedback for design projects and bringing emphasis on conceptual principles, structuring the model and simple programming into earlier stages of the teaching programme and a simple excursion into programming. Studio project examples indicate the interplay between teaching, learning and achievement. Some evidence is explored in greater detail. from the "Interstitial Layers" project utilising the appropriateness of CAAD to store and switch the visibility of spatial data in endless permutations and extensive combinations for mapping, analysing and strategically projecting patterns of city centre activities, fabric and space. Students' demonstrate a dynamic command of CAAD: as a vehicle for conceptual design, a device to analytically review, criticise and modify the design, as a means to explain design ideas to tutors and to develop and detail final building designs. Reciprocal valuing of quality CAAD achievement between architecture students and staff is seen to be contributing to involvement and motivation, reinforcing striving for equality of achievement. Reference to a further strand of the new methodology considers the impact of tutoring based in researcher findings from video case study precedents of architects practising creative design through use of computers, on a more open, effective development of the architecture students' own designing processes, culminating in interesting design work.*

#### **Introduction**

Exciting and creative computer originated creative architectural work is emerging at LJMU throughout the various levels of the architecture courses. This appears to be related to a number of teaching initiatives, enhanced from 1986. CAAD teaching and learning policy enhancements from 1994 have drawn on established pedagogical methodologies, CAAD teaching practice experience here and good practical traditions in architectural education.

Since these policies involve progressive development of CAAD knowledge, expertise and application; the new approaches and the manner of their application to specific projects is detailed appropriately under the headings for Levels 1, 2 and 3, but some reference to the generalities and rationale occurs in the introduction.

The use of 'Electronic Design Media' in the title is used to emphasise; a broadening of traditional CAAD teaching beyond standard program routines, innovative use of tools and commands, mixing and moving between associated programs and use of associated peripherals. (eg. sketching with digitising pens, scanning in scaled traditional plans and using media to enhance output).

Phrases such as 'Architectural Designing With Computers' are occasionally used to emphasise that the educational drive is towards creative computer work, since CAAD has often been abused as a term to refer principally to computer modelling of design ideas already developed in other media. 'CAAD'



may be used for brevity, but still intending this extended meaning. 'Precedents of creative use of CAAD' is used to suggest case studies of researched, identified and valued computer assisted approaches, or processes used by architects for architectural design. 'Product' refers here to the culminating architectural design, whilst 'Process' refers to the ideas, method, media and tools used to develop and express the design.

CAAD teaching has been and continues to be generally based on ArchiCAD © :- for simplicity of structure of the program, its application for novices, facility for layering and floor structuring of plans, visualisation output in a variety of methods (including QuickTime VR, picture mapping), definition of attributes for materials, comprehensive control of sunlight studies. Further, it is valued for its extension to advanced, structured, quality, complex work allowing comprehension through programming, or predesigned object manipulation.

The new initiatives expand and improve earlier teaching and learning policies (developed since 1986), which had gained a degree of acclaim from national CAAD tutoring peers and success in both a general body of CAAD able students and specific annual competition awards. The significant aspects of these policies are not particularly elaborated in this paper, however they included:- CAAD learning being based in design projects, academic learning being emphasised through reference to general conceptual frameworks of CAAD packages with reference to limited actual procedures, rather than total reliance on a system of isolated practical program-specific training, "Learning by Doing" synchronised to the point of need for application to the project, restriction to a "Need to Know Basis" and selection of appropriate CAAD routines to match the specifics of each project. These policies introduced confidence, competence and above all, rapid application and development of models and visualisations of relevance to the studio projects.

Certain learning issues remained to be resolved. Maintaining impetus was challenging. Introduction and intensification of modularisation of the programmes of study brought loss of formal assessments for CAAD and a sharpening of other assessment targets sometimes to the detriment of student CAAD activity. Final year students particularly tended to opt out of CAAD in their anxieties to meet design deadlines. Students seemed to believe that designing of innovative forms was limited by CAAD.

The most serious problem was that many students seemed unable to retain knowledge and skill through to the next year as a basis for extended learning. It is demonstrated that for the average student, retention of CAAD skill is difficult from week to week and more so in respect of gaps of a whole semester. This was most evident as a cohort of fairly successful Level 1 students enrolled and commenced Level 2 CAAD, or as ex Level 2 students started Level 3. The majority seemed to require considerable refreshing and were slow to attain and surpass their earlier performance levels.

Whilst the established principles of the earlier policy were retained, a number of new initiatives were introduced to address the problems which now remained. The resultant objectives of the new methodology learning objectives include:

- a to improve motivation and architectural standard by collaboration of CAAD & design tutors
- b to increase retention of early learning as a stronger basis for extended learning, through requiring students to reflect and report on the CAAD processes they have used and through feedback at interim reviews, final reviews and tutorials
- c to facilitate organised structured work through layers and vertical plan separations
- d to increase creative, innovative use of CAAD through innovative fuller use of tools including creation, manipulation and programming of library objects
- e to inspire creative performance through feedback from precedents of creative designing with computers identified in the team's research work.

As the 1994 cohort of students progressed through to Levels 2 and 3, their CAAD performance showed remarkable responses in learning and application. The details of this process and progress follow with reference to the new teaching inputs. With the ensuing two new intakes the learning policies have been enhanced and elaborated.



### Level One benefits in interim review and learning focused on process

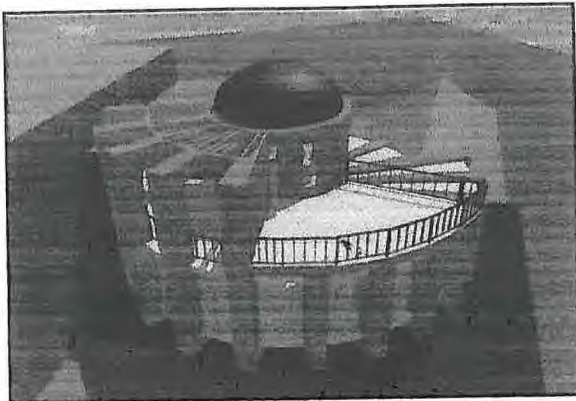
Seeking to encourage students and staff to consciously acknowledge and reinforce understanding and skill; collaborative work with design tutors resulted in modifying the existing learning outcomes (which had already achieved particular success). To underpin and assist later levels of learning, two new significantly different learning delivery strategies were implemented. Firstly, starting with the 1994 cohort, **interim reviews** would mirror good architectural review practice in requiring student reporting on what CAAD processes they used and how this served development and representation of their design ideas (and the final product). Secondly, **feedback** in review would enable corrective tutoring for working more accurately and valuing of, and renewed reference to procedures. Students were then able to improve on their use and understanding of CAAD for the final review.

Students were required to introduce a leisure facility in a local urban context. Alternative volumetric forms were designed and considered for appropriateness. The essential CAAD benefits of visualisations, sunlight shadow casting and rendering of materials attributes were employed. Students valued this easy means to create and test design ideas, since early conceptual ideas are often elusive. Typical remarks included "it has actually proved helpful, just as you said it would."

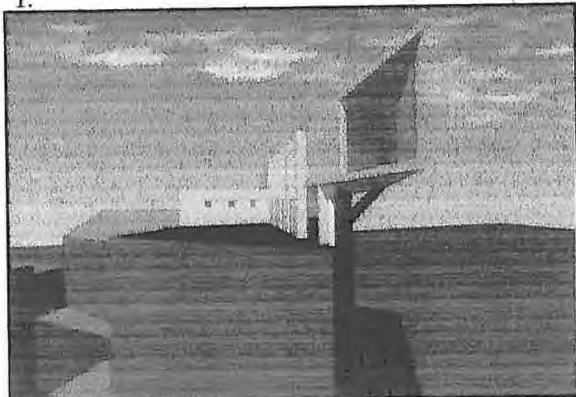
The later variation to design a "Lofthouse" (Figs. 1,2 & 3) for a host or surrogate building, indicated the extent of development of comprehension, skill and appropriate application in design and extracts from students' CAAD statements: "I learnt to use a series of commands. . . and materials for facades." "proved to be an ideal opportunity to explore the program" "enabled me to look at views from the lofthouse out over the city." "gave a clear indication of scale and appearance." "contribution towards my visual comprehension of urban forms and interiors was tremendous, since it allowed me to understand and appreciate the spaces which I myself had created." "the facility of being able to adapt elements such as walls, roofs, windows, doors etc., the effects of sunlight and shadows and to define colour, shininess, reflectivity, and transparency present possible solutions to the lofthouse in suiting the functions, lifestyle & personality of my astronomer character." (client).

The following "The Street & Apartment," project, developed and reinforced CAAD skills exemplified (Fig. 4) by the galleried cafe and bakery interior designed around the central oven flue interplaying light and shadows and tutor, Phil Lo's preference for media mixing CAAD originated work, elaborated with pencil, crayons and montage techniques (eg. Fig.5).

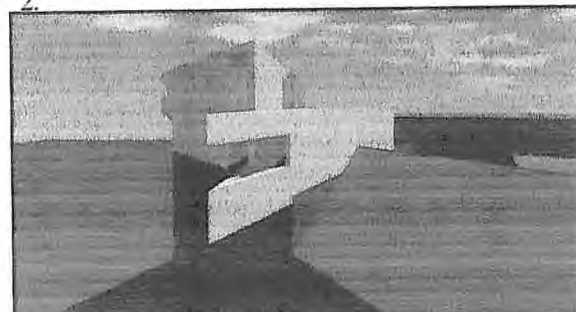
The change in emphasis from assessment of CAAD printed products to considering process, reinforced and pointed up learning achievement to students and to staff, assisting retention of learning as a platform for Level 2 advanced learning.



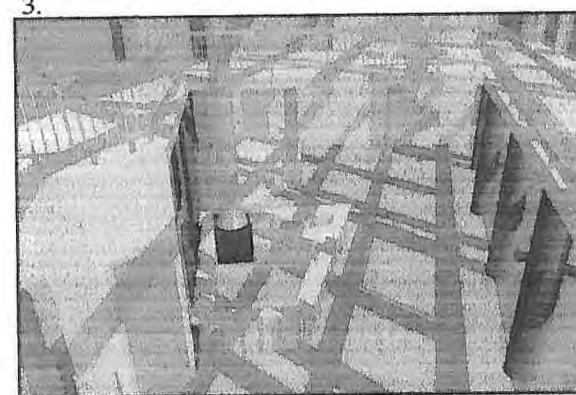
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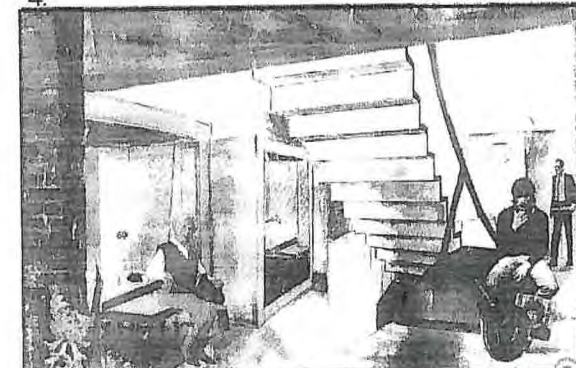
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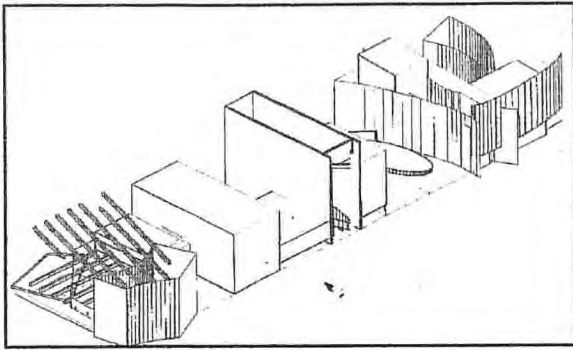


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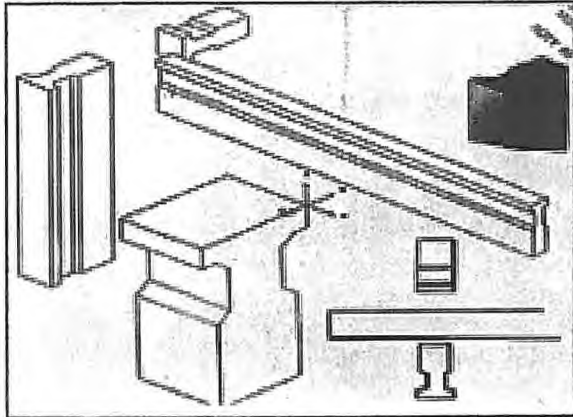


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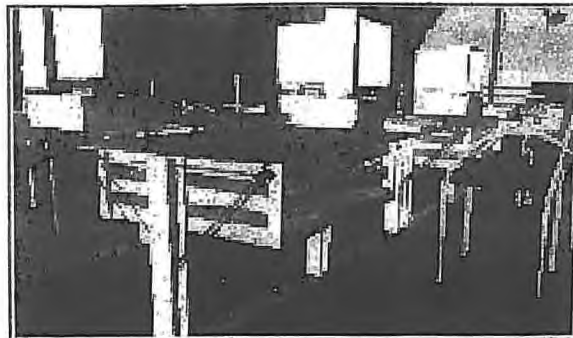
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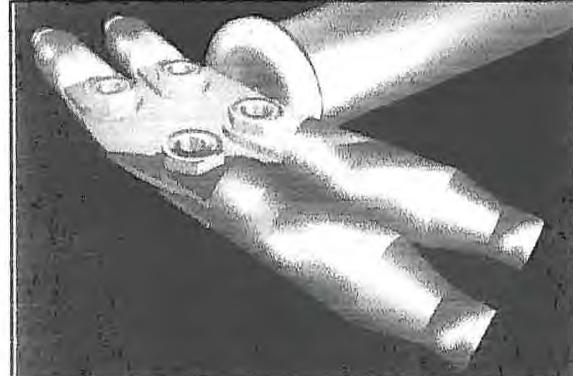
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## Level 2 Comprehensive Cumulative Learning

The policy introduced new principled approaches based in deeper comprehension of CAAD, building on students' established, lasting Level 1 learning basis. Application of CAAD work in the **"Site Analysis and Urban Study"** proved successful, with learning strategy focusing on principles of structuring the model by floor plans and by switchable layering to give more professional control of the model. Eg. with reference to fig.1, Morel Rowlinson, design tutor's remark, "Using the computer as a tool for design, students are asked to model in CAAD volumetric options for integrating new into old on an urban block" indicates recognition of the creative potential of CAAD. Cooperation, including holding design tutorials in the CAAD Suite provided a source of motivation.

In the **"City Transformations"** project the student must focus on a particular existing building and demonstrate its potential for reuse as a place of work. Tutors require accurate modelling of existing structures. Innovative use of the full power of each tool was encouraged, particularly regarding library objects. To facilitate more successful modelling of building structures, this was developed to introduce simple programming. This appeared to increase competence, strengthen confidence and improve comprehension of the potential and basis of 3D CAAD programs. ArchiCAD Geometric Description Language programming commands were explained through reference to preprogrammed library objects, exploring the connections between commands and the 3D forms and actions to these which they effect. Exercises involving limited programming commands were applied to create simple 3D geometric objects and control them through locate, rotate & rescale commands (eg. fig.7 and facade of fig.8).

Since ArchiCAD version 4.12 was still in use; to model forms shaped in a vertical plane necessitated formation in the horizontal plane and rotation either by defining an elevational view to become the top view during creation as a library object, or by rotation in scripting. Production and modification of new parametric library objects became a norm and appeared to bring improved design expectations and a growing reversal of earlier notions that CAAD limits design of innovative shapes, or non standard forms eg. to model the existing complex structures of buildings to be refurbished.

The third project, **"Poetics of Workspace"**, required students to design specific furniture and workspaces for particular clients. Outcomes indicated exceptional use of object creation and manipulation, and careful structuring of the models. Interestingly quite impressive experimentation in complex object creation is now occurring throughout the years, sharing and valuing each others' achievements, eg. fig.10, C.J.Dunne's structural pin from Level 6 design.



### Level 3 learning strategy

Progress to level 3 was well founded now in deeper and broader learning established in the previous two years. The essence of CAAD teaching to Level 3 built on and developed this teaching, emphasising the full potential of each tool, (in order to encourage innovative use), creative opportunities arising from creation, modification, programming and clustering library objects, the conceptual notion of potential structures in the 3D CAAD model and the analytical and futuristic idea generation possible through the switchable layers.

Learning was driven in the first semester by the new design project envisaged by the architectural studio design tutor and supported by the CAAD teaching team. The next section describes Gary Brown's "Interstitial Layers" urban analysis project and how CAAD was essential to its success.

Layers were an essential vehicle to storing data of the present patterns of activities. The "sieve map" notion of plotting data on a set of transparent overlaid sheets becomes cumbersome, when dealing with large amounts of data, which overlap locationally. Layers in principle are more manageable, since unique names can be attributed, colours can also be selected and layers can be switched to show or hide at will in any combination or isolation. Analysis therefore is particularly well supported, even though ArchiCAD was not designed for such urban analysis. The visibility of the CAAD medium, in which extensive combinations can be viewed in endless permutations to highlight, superimpose and generate 2D and 3D pattern potentials was a vital aspect of the process.

The advantage of well managed, organised, co-ordinated use of layers was explained as a facilitator for spatial analysis, which meant unique consideration of sets of complex abstracted patterns of activity, fabric and space development over time. Teaching was very task specific also supporting both programming and direct model building methods for library object creation and manipulation and demonstrating how complex library objects might be clustered for conceptual representation. Subsequent reference to student take up of ideas for experimentation with rotation, displacement and repetition commands should indicate culmination in extraordinary, innovative 3D proposed complexities as responses to the brief.

Considerable effort is expended in attempting to deliver LJMU equal opportunity principles in CAAD learning, for all students in all years of the architectural courses. In short, although also striving to encourage the highest possible standards, this policy appears to have differed from many schools. An important objective was thus to diminish differential in performance and confidence between students. This was partly pursued through group supported shared learning activity, growing towards essential individual activity, by the gradual passing of responsibility to the less confident, with team encouragement. So, students were encouraged to act in a mutually supportive manner towards a resultant narrowing of the gap in CAAD capability.

Learning in the second semester was delivered through design and CAAD tutorials, simultaneously led by the CAAD research student, (Jon Moorhouse) who is a qualified architect. These two characteristics were seen to be of significant relevance for final year CAAD learning and application. This enabled reference to precedents drawn from research into alternative approaches to creative designing with computers by practising architects. The intermediate project involved development of a group urban strategy and manifesto as a basis for the concluding, individual Comprehensive Design Projects. The whole thrust of Level 3 CAAD was to example, encourage and support, structured, developmental innovative, creative design for the design projects. The search continues, to identify which approaches best assist architectural students, still based on integrating their CAAD learning within projects. However what could be better than the research records of video snippets illustrating how practitioners design with CAAD. Certainly students value evidenced CAAD activity by such professional peers, more highly than the same activity explained and demonstrated in teaching where such peer verification is not present.

The achievement of learning outcomes including the extent of expansion of creative use of computers is explored in the following pages, including the "resultant learning" section.



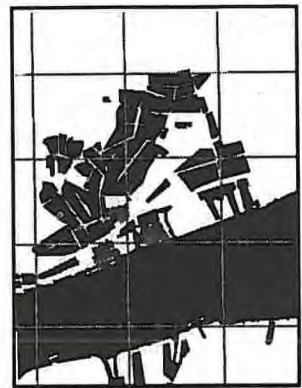
## Interstitial Layers

The aim of the programme was to create a means whereby existing cities could be interpreted as a set of information patterns which would accurately represent the facilities and fabric of the city. The holistic set of information patterns seen as an artifice could then be utilised as a context primer for exploring and assessing future scenarios of development for the cities.

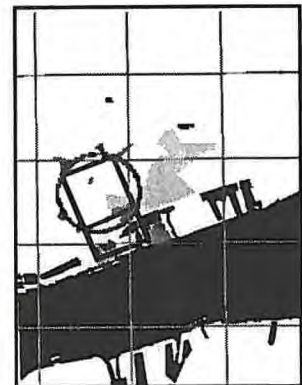
The approach was driven by the idea that pattern recognition and pattern creation are inherent to our comprehension and manipulation of the environment which we inhabit. Pattern recognition is taken as the ability to group individual entities and events of empirical data under abstracted themes, thus forming categories and philosophies of association. This ability to abstract has enabled us to project and intervene successfully in the environmental patterns to our benefit. Today's cities are artifices; reflective of our actions and social strategies as patterns, but these patterns do not evolve relative to the dynamics of nature or 'our own nature'.

Existing cities already contain innumerable diverse and complex patterns from the past, some of which restrain the city's re-facilitation whilst others are essential as existential footholds (they constitute the image of the city and hence give us identity, context and meaning). This sets up a conflict between the city matrix as facility and identity which can also be viewed as a relationship between transient facilities and more permanent image as meaning or spirituality. In redesigning our cities we need a methodology of approach that can reveal these city patterns as a holistic organism, accepting the prevalence of the past, and growing in a way that re-facilitates and reinterprets our cities advantageously with patterns that offer both appropriate facility and spirituality. Inhabited landscape somehow needs a means of starting from simplicity and building into the most complex of systems. A series of base blocks identified with a coding system that formulates patterns that are contextually evolutionary, where the context as an evolutionary dynamic in itself is the sum of 'our own nature' within nature.

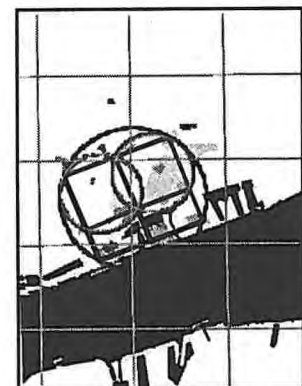
Computers are useful tools when processing complex information, storing and variably displaying large amounts of information at one point in time. The city as an artifice can be interpreted and categorised into a series of information layers. Consequently the complex interrelationships between representative patterns of information, constituting the city artifice can become more apparent within the machine space. Machine space also enables the city's pregnant patterns to grow as a set of variably evolutionary dynamic scenarios where the outcome of overlaying, inserting and amending of any pattern or combination of patterns can be assessed in association with all the other patterns, testing and reciprocally assessing potential future city scenarios. In this way the machine space becomes the means 'to see' and actively participate in the city



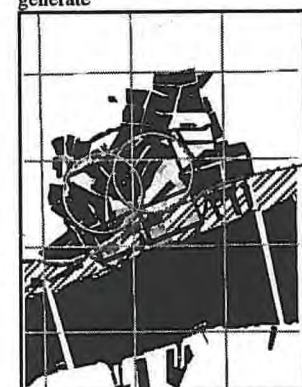
11 Accumulated image of Liverpool, routes, edges, fields, positive and negative nodes;



12 Formatting of the existing image into a geometric order based on the negative nodes

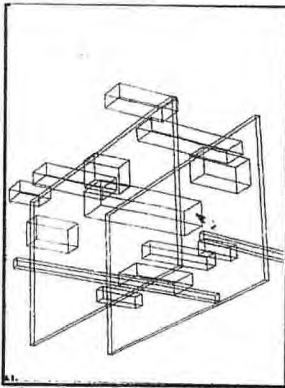


13. Extending the geometric order into the hole as a skeleton around which identifiable fabric can generate



14 The new geometric order in the context of the existing identifiable fabric and the hole.

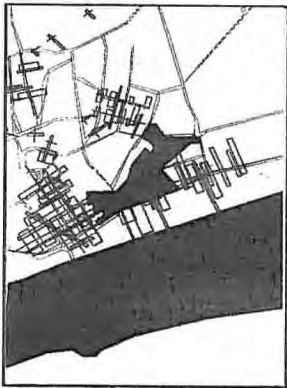




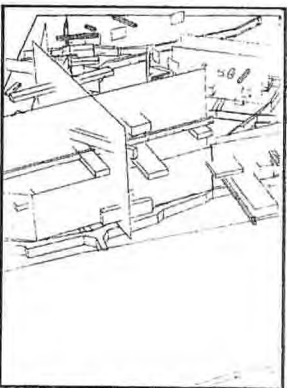
15. Services, representative megalope behaviour pattern. Areas developed as nodes feeding the areas they service.



16. Block patterning of the distribution of services throughout the city centre of Liverpool



17. Two dimensional plan of existing services as megalope behaviour pattern.



18. Three dimensional megalope behaviour plan as projected pregnancy for the future city according to manifesto addition.

as a set of interrelated patterns, which would otherwise be too large and complex to grasp. There is of course the problem of the interpretive transfer of the city artifice into the machine. What complexity of interpreted information as categories of layers is acceptable such that the combined permutations can be manipulated, whilst still being comprehensible as a representation of the actual city?

The city artifice was initially segregated into two distinct forms of information consisting of uses (mutable) and image (immutable). Immutable as existential foothold was categorised through references back to a set of interpretive observer classifications that distinguish the holistic city matrix. Kevin Lynch's *Image of the City* studies (1960), adapted to, *Routes, Edges, Fields, Negative Nodes and Positive Nodes*). These categories as accumulated patterned layers within the machine space reveal the combined existential foothold patterns and any potential pregnancy. This pattern pregnancy can then be projected into a skeleton of existential footholds, or the bones around which the flesh of the city's uses can grow and mutate. (Figs. 11-14 show a geometric relationship between negative nodes as a circle and square. The potential in this case was to produce a second intersecting geometric set of negative nodes, to prime the development of fabric and facility in the hole between identifiable fabric fields and so reconstruct the city).

The initial study of the city as image was then overlaid with a further study of uses that comprehensively described the city. The uses were categorised as *Administration, Communication (Transportation), Education, Retail, Service, Accommodation, Entertainment, Production, Storage, Waste* taken from *Ubiquitous Urbanism* (Hadid, 1995). These uses were then interpreted into distinctive three dimensional use patterns relative to the behaviour of that use as a planned morphology within the city. (This interpretation was termed mega-lope behaviour). These interpreted patterns were overlaid within the same space of the machine as the image patterns, revealing how the city functioned as a set of uses in relation to the populace's image of the city, or the mutable overlaying the immutable. The two sets of patterns were used in conjunction with distinctive aims for the city's future (in the form of a manifesto) developing the flesh of facility, as use within the bones of the 'existential footholds'. Each interpreted use pattern was taken as having a potential for growth or reduction relative to innumerable possible future scenarios for the city. The effect of amending one pattern can be assessed within the machine space in relationship to the holistic artifice, as can any permutation of amendments to any permutation of uses.

To summarise, the steps of the programme were: 1. Choose a city as a laboratory (Liverpool). 2. Analyse the city in terms of a set of observer classifications. 3. Input the information organised by CAD layers (Archicad v.4 in this case). 4. Assess the combined

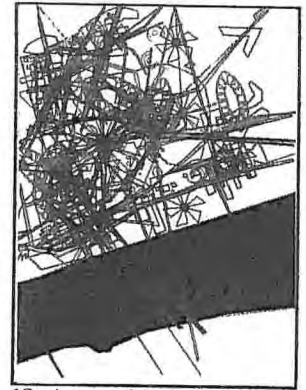


information patterns and project the unrealised potential of the city as a skeleton. 5. Analyse and categorise the city's uses in a set that comprehensively describes the city. 6. Overlay these use patterns on the unrealised city skeleton. 7. Interpret the uses into patterns that represent the behaviour of that use as a planned morphology within the city (mega-lope behaviour). 8. Assess the city as a facility within a global context and project its future potential as a manifesto. 9. Apply these manifesto aims to the future of each use pattern, amending each, relative to the potential future. 10. Assess the impact of the mutable pattern potentials in combination with all other patterns. 11. Redesign the patterns such that the most appropriate permutation emerges relative to the manifesto aims. 12. Overlay, insert and amend the existing city fabric with the amended use potentials.

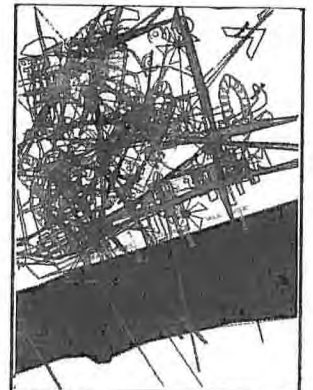
Students undertook the programme in groups, the main difficulty being with the interpretation of the use patterns into three dimensional patterns representative of the uses 'mega-lope behaviour'. Students would constantly return to these abstract representations in an attempt to distil the essence of that use in the most appropriate representative form. This was due to the different behavioural development of uses through the ages, in many cases no singular pattern was appropriate, however in order to recognise and manipulate the patterns it was essential that these representations have similar pattern characteristics. Whilst the programme could be criticised for treating the city too much as an information artifice with only 15 different information categories, insinuating a divorcing from reality, this approach did yield a certain interpretive freedom in terms of the city's future. Students were unafraid to create sweeping changes to the whole city. In addition this approach was only part of a wider programme, this part being used to devise an appropriate context for a specific area of the city called the interstitial layer. The programme progressed into 1:500 scale models of actual fabric in this area of the city.

Strong principles of equality of opportunity underlie LJMU education policy. CAAD learning, despite the inevitable resource limitations, included a general levelling-up of skill throughout the cohort. For students who already demonstrated strong ability, an even greater appetite for experimentation became apparent.

The success of the Interstitial Layers project is evident. It has proved to be of particular benefit, as a catalyst which injected excitement and diversity into an already strong approach to CAAD and the encouragement of a freer approach to designing through the computing medium. The introduction of a project which **demands** computer use, (for it could not have been performed otherwise) in such a way that preconceptions regarding the perceived benefits of CAAD are reassessed, clearly opened up new possibilities for the students and will be further developed next year.



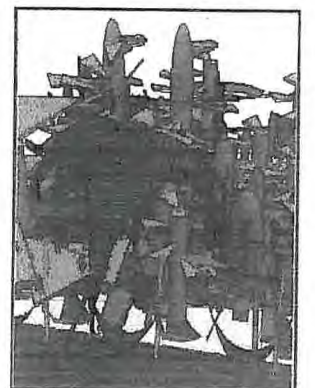
19. Accumulated existing uses for the city of Liverpool—plan



20. Accumulated existing uses projected relative to the application of a manifesto—plan



21. Three dimensional view from the river of the uses as projected—hidden line.



22. Three dimensional view from the river of the uses as projected—coloured.



## **Building on Learning Outcomes following the Interstitial Layers Project and the Three Year Teaching Approach in General**

Following the Interstitial Layers module, the second semester teaching strategy is with a view to reminding level three students of the qualities of CAAD features which might also be applied to their urban design strategy and manifesto (a course requirement) and to their final Comprehensive Design Project which requires building designs encompassing structural, technological and environmental strategies within an overall urban context. The key difference in this semester was a weekly tutorial-based learning process in the CAAD suite, serviced by a qualified architect/researcher. This enabled coincident advice on the CAAD and architectural design issues. The most dynamic aspect of this formalised teaching input was the reference to precedents of various architects' creative use of computers in practice. (Kokosalakis & Moorhouse 1995a, 1995b), (Moorhouse, 1996). Four notable examples of students' work which have drawn upon such precedents through directive tutorials are offered here.

**The first, Hannah Lawson's 'Central Station'** involved early experimentation with form and included the modelling, and subsequent rejection, of a conical hole linking ground and platform levels. Since ArchiCAD version 4.12 was in use, the form was best developed using simple scripting (GDL). The final design was rendered within ArchiCAD, with a preconceived outcome in mind, and 'touched-up' using PhotoShop. Scripting, imaging processes and the use of different software to produce a final image were drawn from precedents expressed by Richard Dudzicki <sup>1</sup>.

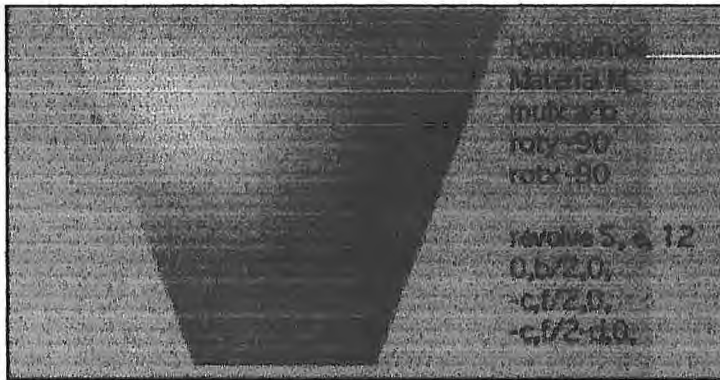


Fig. 23. Hannah Lawson's GDL cone.

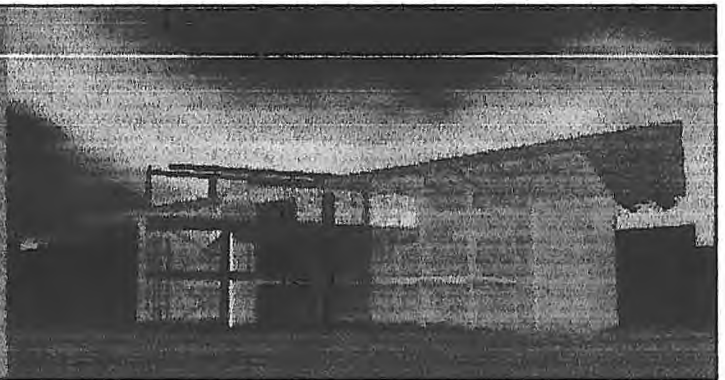


Fig. 24. Hannah Lawson's final scheme.

**The second scheme, Kharriat Siddiq's 'Mediatheque'** explores a complex arrangement of levels and mezzanines on a sloping site. CAAD was used to develop a 3-Dimensional understanding of the relationships between vertical levels throughout design development. Parallels were drawn upon from the approach demonstrated by Chris Pritchard <sup>2</sup> where the control of layers and production of simple 3D renders were used to examine junctions between slabs and levels in the design of the National Museum of Photography, Film and Television extension in Bradford, England.

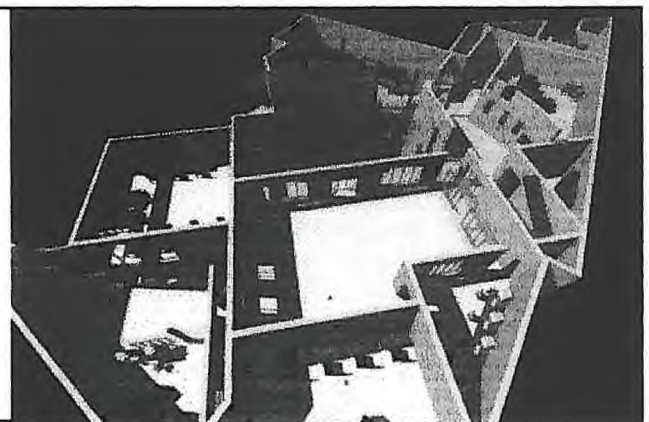
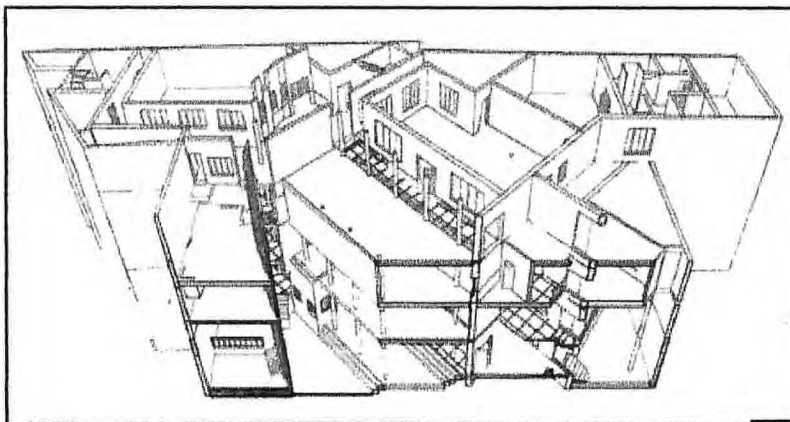


Fig. 25 & 26. Kharriat Siddiq's Mediatheque, axonometric and rendered perspective.



In the third scheme, Daniel Robinson used a combination of computer and physical modelling to sequentially develop a complex series of formal relationships from urban massing to refined detail for the Central Station project. The approach here draws strongly from precedents and general practice observed from Lee Hallman, which include design development through modelling in various different media <sup>3</sup>.

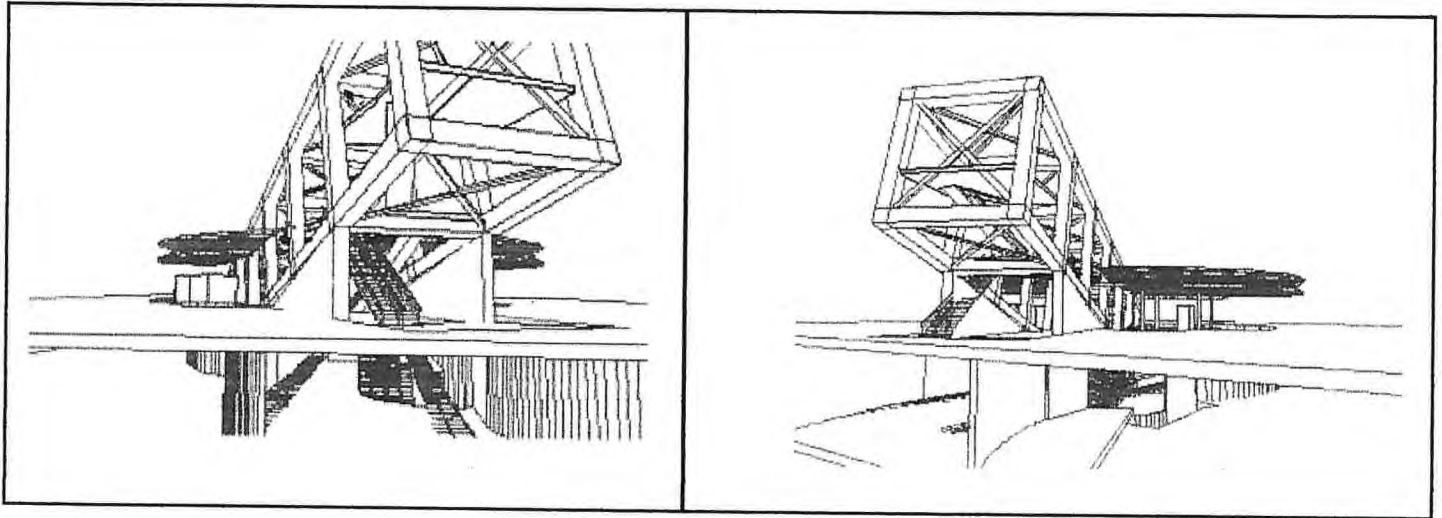


Fig. 27 & 28. Daniel Robinson's Central Station

The fourth scheme, Wai Lam Wong's 'Mediatheque' follows the approach used by Neil Clark <sup>4</sup> in rigorously examining the implications of each design decision from urban to elemental design by using a series of 3D CAAD models, photorenders and animations, assessing the effects of space, lighting, materials and textures.

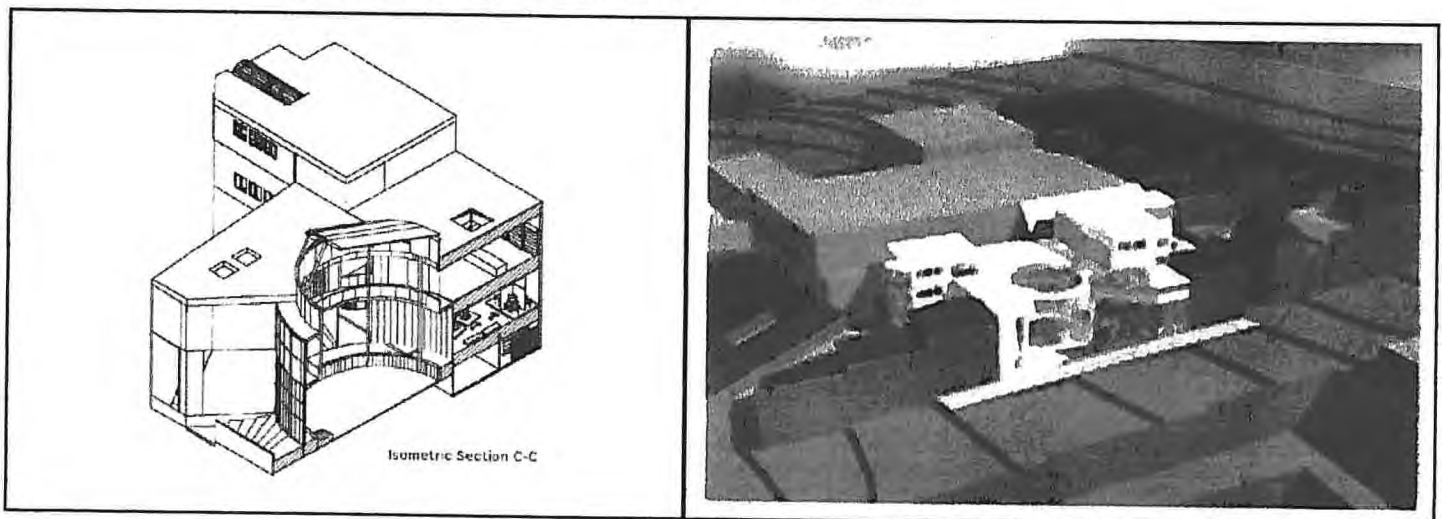


Fig. 29 & 30. Wai Lam Wong's Mediatheque, axonometric and context model.

What became clear during this final project (if not always visible within the students' final presentations) was a tendency for the students to begin considering (and, more importantly, utilising) CAAD as a design medium. The value of CAAD was expressed by different students in different ways, largely through their development of individual design approaches. Ease of use, and integration with more traditional design media, allowed even the more reluctant student to 'dip in and out' of CAAD throughout the design process. The more advanced students were confident enough to experiment with, and move between, different design and graphics software. Conceptual activity was further increased through, for example, using layers to examine different options. This was an important shift for many from modelling and visualising predetermined ideas (although the value of visualisation was not undermined). The use and creation of library objects, particularly through juxtaposition, allowed experimentation with form. In the same way, the main tools in ArchiCAD were frequently supplemented by GDL scripting. A tendency towards considering space and form rather than edges and outlines was demonstrated on macro and micro levels. In this way the strong tradition of exploring urban context through quickly generated block 'site' models was transmuted to smaller scale massing and spatial analysis. The success of the cohort as a whole gives credit to the developed didactic approach, experienced over 3 years, together with the delivery of appropriate tutoring with reference to precedents.



## **Resultant learning**

Considerable acceleration and consolidation of learning appeared to follow from embracing CAAD into the good learning practice and tradition of early crits and feedback in architectural design studio interim reviews and the further good practice of requiring learning outcomes demonstrating the process of CAAD activity which lead to the product (the design, or the CAAD model). In **Level 1** improved accuracy and control of 3D models was achieved through requiring students to recount **how** they built up their models, particularly reviewing their selection of appropriate data entry methods, use of the intelligent cursor and effective vertical structuring and layering and the advantages and difficulties they encountered. This often revealed which aspects of learning they had failed to understand or apply and provided an opportunity to reinforce these points, resulting in phenomenally improved performance. The opportunity to learn from mistakes, or lost opportunities and apply this immediately, to improve the 3D model for the current project seems to have been an important aspect leading to reinforced learning tending to bring better retention. Transfer to Level 2 subsequently occurred more seamlessly with students prepared to extend their CAAD learning rather than having to repeat forgotten basic learning.

Amongst the benefits from the more advanced and yet fundamental learning innovations at **Level 2** can be found: skilled, accurate, creative work, innovative use of tools and objects, improved contextual grasp of the urban context, relevant, responsive, conceptual manipulation of urban interventions, clear, confident comprehension of CAAD process and more thorough adventurous CAADesigning. Teaching appears to have brought a strength, based in better comprehension, from which a degree of excitement, enthusiasm and perhaps daring has emerged. Such confidence and competence proved an excellent springboard for Level 3.

The most remarkable results are considered to be the current graduates' from **Level 3**, culminating in striking work involving all students, directed by their design tutor in the first semester and supported by tutorials from the CAAD researcher/ architect in the second. Improvement in the architectural design quality of CAAD work could be seen as an inevitable outcome from the institution of CAAD tutorials by architects. Following the improving performance of these students, a process of reciprocal valuing developed in which design tutors began to appreciate and encourage CAAD as a vehicle for the project design. Students' motivation and activity must have benefitted from further professional peer endorsement of the taught CAAD processes and opportunities by reference to the research precedents emerging from video documentation of creative computer activity by practising architects.

Having all been involved in the CAAD aspects of the Interstitial Layers and urban strategy development, two thirds proceeded to develop and present CAAD work in final designs. The levelling upwards and levelling out of differential between exceptional skill and general competence is of particular interest. Also this is the first occasion that such a degree of commitment to CAAD activity, has been made by final year students. Previously, few students felt confident or motivated to progress their use of CAAD into Level 3 projects. The process culminated in demonstrated practical achievement, based in greater reflective comprehension of broader issues of general processes at play, encouraging all students to value, retain and innovatively apply CAAD learning. Students indicated a dynamic command of CAAD (many use it as a vehicle for conceptual design, as a device to analytically review, criticise and modify the design and to explain design ideas to tutors.

## **Conclusions**

Growing effectiveness is evident, as new learning policy initiatives reinforce the original strategy, showing improved reception, and retention of deepened and broadened skills, comprehension of the processes of CAAD and their application to design work and creative achievement.

There is greater cooperative support across the team with staff development of their own CAAD skills and growing staff appreciation of CAAD, particularly as students are better able to hold dialogues with studio tutors, about what they are doing and why and what they hope to achieve. Many staff and students would still not accept that CAAD is a creative design tool, but are able to see the evaluative role which it can perform in the design development, beyond the purely presentational role, which is was not always valued, but better known. New learning challenges are



usually more difficult for established professionals than for students, but greater sharing of ideas and collaboration brings progress and a lessening of difference between studio and CAAD staff objectives. Strengthening of the CAAD team's research findings feeds in greater expectations, acceptance and valuing of creative use of CAAD in designing.

The experimental collaboration between studio and CAAD tutors, has been endorsed through a formal policy, which is now in place, requiring design module leaders (studio tutors) to actively seek to incorporate CAAD into appropriate design project briefs. This is particularly heartening with reference to a now aging paper (Kokosalakis & Rainger, 1990), prepared for SCHOSA, extolling the value and urgency of design tutor involvement in student CAAD activity.

The traditions of established learning methodology, enabled identification, retention, redirection and development of valued learning approaches in design studio and CAAD practice. Perception of aspects requiring further attention was facilitated and the emerging strategy appears to have been effective.

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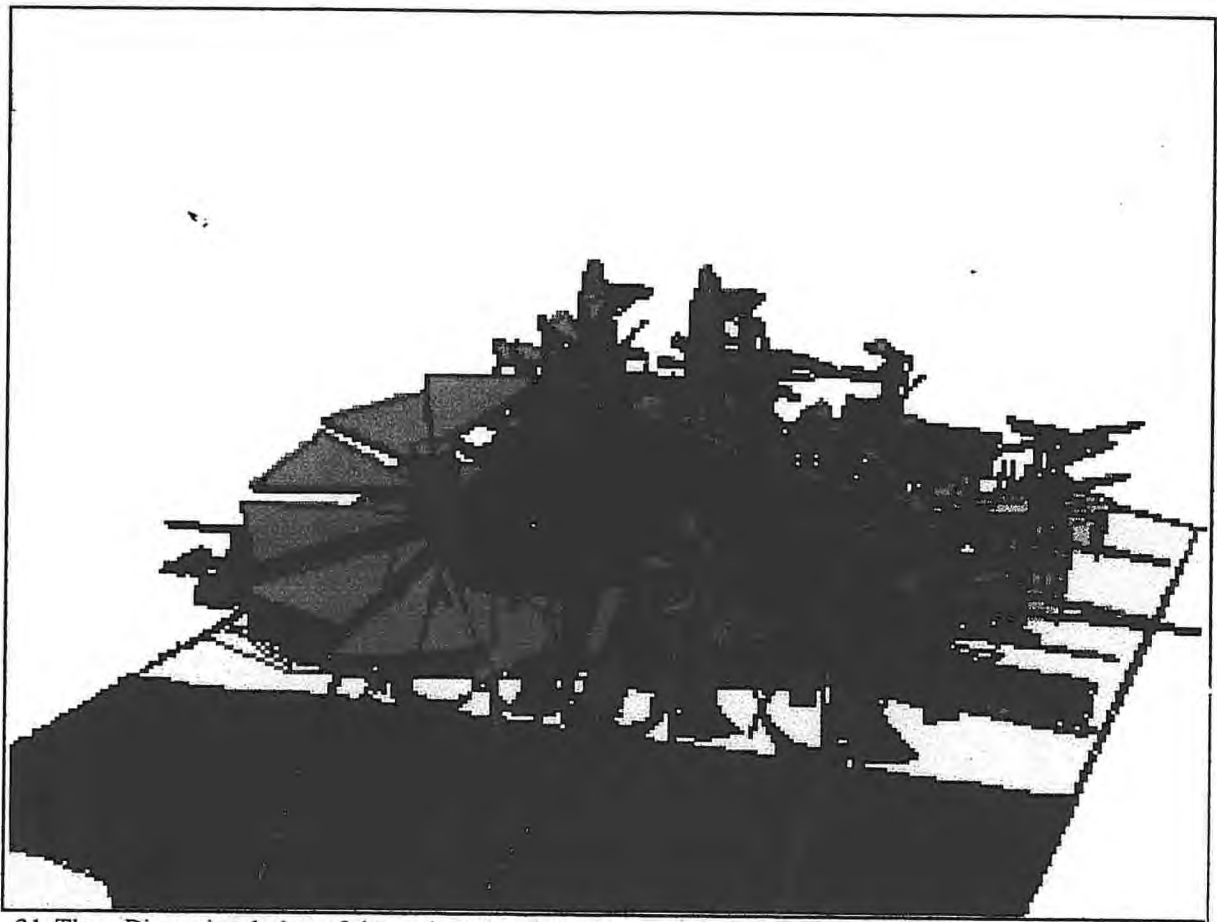
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*Student illustrations include work from Stephen Lavin, Mark Gerry, Keith Hill, Wei Wu, Dominic Choi Iok, James Hall, Alan Lewis, Gordon Fortune, Crispin Tedbury, C.J. Dunne, Elizabeth Davies, Hannah Lawson, Kharriat Siddiq, Daniel Robinson, Colin StuhlFelder, Wai Lam Wong, and other team members.*

### **Acknowledgement of Precedents.**

- 1 Richard Dudzicki, Dudzicki Associates, London, 1996.
- 2 Chris Pritchard, Austin-Smith:Lord, Warrington, 1997.
- 3 Lee Hallman, Sir Norman Foster and Partners, London, 1996.
- 4 Neil Clark, the Nicholas Grimshaw Partnership, Manchester, 1996.





31 Three Dimensional view of the projected activity uses from the river student group .2



32 Detailed three dimensional view of the projected uses in the area of the interstitial layer



33 Detailed three dimensional plan view of the projected uses in the area of the interstitial layer